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ABSTRACT: While there is an extensive literature detailing the change in industrial employment resulting from changes in trading patterns, there is no significant literature that translates these changes in labor demand to actual worker hardship. This study provides evidence of the labor market effects of changes in import and export competition throughout the 1980s by focusing on the level of industry displacements, workers involuntarily separated from their industry of employment, rather than changes in the level of industry employment. The results therefore shed light on the number of workers that were measurably injured by changing trade patterns.

The analysis is based on a general equilibrium specification that yields an equation describing the influence of specific industry measures of competitiveness, along with changes in the aggregate environment, on displacements. This equation is subsequently estimated using import and export transactions prices maintained by the Department of Labor in conjunction with data from a series of Displaced Workers Surveys. Counterfactual analysis provides an estimate of the number of displacements resulting from changes in international competitiveness. These counterfactuals reveal that overall, changes in the competitive position of the United States *reduced* the number of workers dislocated throughout the 1980s.

JEL CLASSIFICATION: F14, J21

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I. Introduction

Many have attempted to quantify the changes in sectoral employment resulting from changing patterns of international trade. These studies have employed a variety of methodologies: basic accounting methods, input–output methods and, more recently, econometric modelling.[1] While these studies provide a quantification of the change in labor demand, by industry, they do not aid significantly in understanding the degree of hardship these changes place on workers. What these studies do not consider is that only a fraction of the change in employment in an industry will be accomplished through firing or laying off workers, the rest is accomplished through unreplaced attritions in the form of quits and retirements. The purpose of this study is, therefore, to quantify the extent to which changes in trading patterns have resulted in displacements of labor; that is, an evaluation is made of the extent to which individuals have involuntarily lost a position in one industry and been forced to find employment elsewhere.

Analyzing displacements is in some sense preferred to analyzing industrial employment because displacements are a more accurate reflection of the adjustment costs, in the form of temporarily unemployed resources, imposed on the economy by changes in trading patterns. Discussing only changes in employment can lead to an exaggeration of the deleterious effects of changing international competition. For example, if two industries are affected by trade, and one industry reduces employment while the other increases employment, then it will appear as though the number of workers injured by trade is equal

[1] A summary of this work appears in Tyson *et al.* (1988) and Deardorff and Stern (1986, Ch. 9).

to the reduction in employment in the first industry. That is, the change in displacements is equal to the number of people moving from the declining traded industries to the expanding traded industries. In reality, however, the number of workers injured will be much smaller. In a dynamic setting, some workers will voluntarily leave the declining sector and, as job opportunities are shifted from one industry to another, new entrants will find employment in expanding rather than declining sectors. Although the outcome of the job search is different, a qualitative judgement as to whether or not they are better off cannot be made.

There exists a literature exploring the extent to which changes in labor demand leads to the displacement of workers. Hamermesh (1969) indicates that a mere 21% of the decline in employment in any industry will be comprised of labor involuntarily displaced from that industry. Brechling (1978), on the other hand, finds that at least 57% of any reduction in employment will result in displacements. The difference in results arises from the treatment of quits. Hamermesh assumes that the level of quits from an industry is exogenous while Brechling treats quits as endogenous. When quits are modeled as endogenous, they tend to decline, as a percent of employment, as employment declines. Declining employment in an industry diminishes the prospect of finding alternative work within the industry resulting in a lower propensity for workers to quit. Conversely, quits increase as employment in the industry increases. The overall message is that displacements are small relative to the change in labor demanded.

There are a number of recent studies attempting to econometrically estimate the influence of international trade on industry employment.[2] This paper builds on the results of these studies in a number of ways. First, the emphasis is on displacements rather than employment levels. Grossman (1987) begins with the question "How important is import competition as a cause of labor displacements and wage movements?" The paper then proceeds to analyze the sensitivity of industry employment, rather than displacements,

[2] See Branson and Love (1988), Grossman (1987), Hashenzadeh and Kasturi (1989), Mann (1984), and Revenga (1992).

to changes in trade patterns. This paper extends the framework presented there to more closely answer the question posed. Second, the model presented here explicitly considers the changes in competitiveness of exports from the United States. Revenga (1992) asks the question "Exporting jobs?", but then proceeds to tabulate the number of jobs lost because of changes in import competition, placing little emphasis on changes in the competitiveness of exports. It is my contention that both of these studies exaggerate the effect of changes in international competition and may serve to fuel the protectionist fires to a greater extent than is perhaps warranted.

The analysis also includes a more comprehensive treatment of traded industries, albeit at a higher level of aggregation, than do previous studies. As a result, this study provides a more thorough accounting of the effects of changes in competitiveness. This study thus includes aspects of the employment changes brought about by international pressures, both within and across industries, that are not thusfar addressed in the literature.

The paper is organized as follows. Section 2 contains a description of the methodology used in the estimation of displacements, and Section 3 presents the data and its sources. Section 4 reports the econometric results from estimating the displacements equation, while Section 5 presents estimates of the number of displacements that are attributable to changes in international competitiveness. Section 6 concludes.

II. Methodology

This section presents an extended version of the methodology laid out in Grossman (1987).[3] The methodology was originally developed to provide a means of estimating the impact of changes in import competition on industrial employment and wages. There are two innovations in what follows. First, to include a wider scope of international influences, the model explicitly includes changes in the competitive environment faced by exporters as well as importers. Second, there is a change in focus away from changes in employment and

[3] As a consequence, Section II.1 borrows heavily from that work.

wages toward the estimation of the number of workers displaced by changes in competitive pressures.

II.1 Long-Run Equilibrium

The output of each traded–goods sector (Y_i) is produced with the input of two nontraded factors, labor (L_i) and capital (K_i), and a traded input, energy (E_i), according to a Cobb–Douglas production function:

$$Y_i = AK_i^{\alpha_1} L_i^{\alpha_2} E_i^{(1-\alpha_1-\alpha_2)} e^{\pi t+\epsilon_i}, \tag{1}$$

where π is the rate of Hicks–neutral technological progress, t indexes time and ϵ_i reflects random deviations from trend productivity growth, assumed to be distributed normally with zero mean and variance $\sigma_\epsilon{}^2$.

Given this specification of production, the derived demands for inputs are

$$E_i = \frac{(1-\alpha_1-\alpha_2)P_i Y_i}{P_e} \tag{2}$$

$$K_i = \frac{\alpha_1 P_i Y_i}{r_i} \tag{3}$$

$$L_i = \frac{\alpha_2 P_i Y_i}{w_i}, \tag{4}$$

where P_i is the price of sector i's output, P_e is the price of energy, r_i is the rental rate on capital in sector i, and w_i is the wage rate in sector i. Energy is assumed to be available in infinitely elastic supply at the exogenously given world price.

The fraction of the total stock of the nontraded factors supplied to sector i is a function of the sectoral return to that factor relative to the aggregate return. Denoting K_a and L_a as the aggregate stock of capital and labor respectively, and r_a and w_a as their respective aggregate returns, then

$$\frac{K_i}{K_a} = C\left(\frac{r_i}{r_a}\right)^c \qquad C, c > 0 \tag{5}$$

and

$$\frac{L_i}{L_a} = D\left(\frac{w_i}{w_a}\right)^d, \qquad D, d > 0 \quad (6)$$

where c and d are parameters reflecting the long-run sectoral mobility of capital and labor respectively. The aggregate stocks of capital and labor are assumed exogenous with respect to each individual sector i, and to traded industries more generally.

The larger the values of c and d, the higher the degree of mobility. For example, in equation (5), as c approaches zero, the importance of the differential between the industry return to capital and the aggregate return in determining the industry capital stock diminishes. When c is equal to zero, capital is completely sector specific; a given industry cannot increase its share of the aggregate capital stock even with very large changes in the rental rate it is willing to pay. Correspondingly, perfect capital mobility, c equal to infinity, implies that an industry has a great deal of control over its capital stock and can effect large changes with only slight deviations of the industry rate of return from the aggregate return to capital. Note that this methodology imposes no restrictive assumptions on the mobility of nontraded factors, and hence allows for the possibility of perfect sectoral mobility of each factor; imperfect mobility, even in the long run, is also a possibility.

The real aggregate returns are assumed to be functions of the aggregate supplies of the nontraded inputs and the price of the traded input, and are specified as

$$\frac{r_a}{P_a} = F{K_a}^{f_1}{L_a}^{f_2}{P_e}^{f_3}, \qquad f_1 < 0,\ F > 0 \quad (7)$$

for the aggregate return to capital, and

$$\frac{w_a}{P_a} = G{K_a}^{g_1}{L_a}^{g_2}{P_e}^{g_3}, \qquad g_2 < 0,\ G > 0 \quad (8)$$

for the aggregate wage paid to labor, where P_a is the aggregate price level. These equations are a particular specification of the restriction that aggregate returns be equal to their marginal physical product in equilibrium. As noted, energy is available in perfectly elastic supply and its price is taken as exogenous to the system. Therefore, the price of energy, rather than the quantity, appears in equations (7) and (8).

Changes in international competitiveness enter the structural model in the form of changes in import and export prices. The import prices are reflective of the actual cost, including customs, insurance, and freight, to the domestic purchasers of the good. The export prices are similarly reflective of transactions in the foreign trade market, absent the cost of insurance and freight. Changes in the import and export prices will also reflect changes in the exchange rate. The mechanism through which the trade prices influence industrial employment is through their effect on demand for the domestically produced good.

Total demand, domestic and foreign, for the domestically produced good is assumed to take the following form:

$$Y_i = B\left[\frac{P_i^m}{P_i}\right]^{b_1}\left[\frac{P_a}{P_i}\right]^{b_2}\left[\frac{P_i^x}{P_i}\right]^{b_3} Q^{b_4}, \qquad b_1, b_2, b_3, b_4, B > 0 \quad (9)$$

where Q is national income, P_i^m is the exogenous price of imported goods in sector i, and P_i^x is the exogenous price received for exports of goods produced in sector i.[4] P_i and P_a are, again, the domestic industry and aggregate price levels, respectively. The supply of imports is assumed to be perfectly elastic.

The domestically produced good in sector i is assumed to substitute imperfectly for imports of goods in sector i and for a basket of domestically produced goods. The demand for the domestically produced good therefore depends on its domestic price relative to the price of each of these alternatives. An increase in either relative price will lead to an increase in the demand for the output of sector i, *i.e.*, the elasticities of substitution between the domestically produced good and both imports and the aggregate bundle, b_1 and b_2 respectively, are positive.

Similarly, in the foreign markets, exports are an imperfect substitute for the foreign product. An increase in the price received for exports can arise through either increased demand in foreign markets for the good or through a depreciation of the currency. In either

[4] Richardson (1974) fails to reject the hypothesis that the United States is a small country for many manufactured goods.

case, domestic producers will expand production in response to the higher price received for a given quantity of exports. Fluctuations in export prices that coincide with changes in the domestic price are assumed to reflect changes in the industry not related to international competition; changes in the price of a traded input, for instance. It is therefore changes in the price of exports relative to the domestic price that signals a change in competitiveness. An increase in the price received for exports of domestically produced goods, relative to the domestic price, indicates a shift in foreign demand towards industry i, the implication being that b_3, the elasticity of export supply, is positive.

After taking logarithms, a reduced form equation for employment can be obtained as

$$\begin{aligned} \ln L_i = {} & \delta_0 + \delta_1 t + \delta_2 \ln K_a + \delta_3 \ln L_a + \delta_4 \ln P_e \\ & + \delta_5 \ln P_a + \delta_6 \ln P_i{}^m + \delta_7 \ln P_i{}^x + \delta_8 \ln Q + u_i, \end{aligned} \tag{10}$$

where the δ_i are all functions of the parameters in equations (1) through (9). The coefficients of primary interest, δ_6 and δ_7, are the following functions of the structural parameters:

$$\delta_6 = b_1 \cdot \Omega$$

$$\delta_7 = b_3 \cdot \Omega,$$

where

$$\Omega = \frac{d}{(1+d)} \cdot \frac{1}{1 + \frac{\alpha_2(b_1+b_2+b_3-1)}{(1+d)} + \frac{\alpha_1(b_1+b_2+b_3-1)}{(1+c)}}.$$

δ_6 and δ_7 represent the sensitivity of industry employment to changes in import and export competition respectively, and will be positive, except in the exceptional cases where $b_1 < 0$, $b_3 < 0$, or $(b_1 + b_2 + b_3) < -1$.

II.2 Displacements

The above provides a methodology for estimating the change in employment, by industry, attributable to changes in trade patterns. The following modifies the system by incorporating a description of the relationship between changes in employment levels and displacements. It is assumed that for each industry there is a positive equilibrium number of displacements. That is, for an industry experiencing no demand growth or technological change, the process of maintaining a labor force of a given size results in individuals being displaced from the industry. These displacements result from natural turnover within an industry. One source of turnover is through the exit of inefficient firms and the entry of new ones. Labor released by the exiting firms will not necessarily obtain employment from the new firms or even within the same industry. In addition, the process of replacing voluntary attritions is an imperfect one involving the hiring and subsequent firing of workers not properly suited for a particular position. The assumption of a positive equilibrium level of displacements is reinforced by the data: displaced workers from industries exhibiting continuous growth are present in the Displaced Workers Survey.

It is further assumed, following Brechling (1978), that an industry's quit rate is endogenous and directly related to the change in the level of industry employment. As industry employment falls, the prospect of obtaining an alternative position within the industry also falls, thereby increasing the costs associated with quitting, reducing the number of quits from the industry. The likelihood of finding a job within the same industry is important to the worker in part because of the potential loss of human capital associated with switching industries. An analogous and opposite process works for an industry with increasing employment. The importance of this assumption lies in its implications for the ability of an industry to effect a given change in employment without incurring displacements in addition to those present in equilibrium. If the quit rate is endogenous, the number of quits will fall with industry employment. A lower quit rate implies fewer voluntary attritions, making it necessary to displace a greater number of workers in order to reduce employment than if quits were exogenous.

Displacements, (D_i), from an industry are modelled as

$$D_i = N_i \left(\frac{L_{i,t}}{L_{i,t-1}} \right)^{-n_i}, \qquad N_i > 0 \text{ and } n_i > 1, \quad (11)$$

where N_i is the equilibrium level of displacements. The parameter n_i is assumed positive and greater than one to capture the relationship between changes in industry employment and the industry quit rate described above.

Equation (11) is illustrated in Figure 1. In equilibrium, there would be no change in employment from year to year, but there would still be a positive number of displacements (N). Equilibrium is then represented by the intersection of the dashed lines in Figure 1 at the point $(1, N)$. As employment increases, *i.e.*, $\frac{L_t}{L_{t-1}} > 1$, we observe less than the equilibrium level of displacements and conversely, as employment decreases, $\frac{L_t}{L_{t-1}} < 1$, we observe displacements in excess of the equilibrium level. The downward sloping line, Z, represents the quantity of displacements that would occur if quits were assumed exogenous, *i.e.*, if $n = 1$. The endogeneity of quits, represented by D_i thus implies that displacements will be lower in expanding industries and higher in contracting industries than if quits were exogenous.

II.3 Estimation

The derivation of an estimating equation for displacements involves taking the logarithm of equation (11), resulting in:

$$\ln D_i = \ln N_i - n_i \left(\ln L_{i,t} - \ln L_{i,t-1} \right). \quad (12)$$

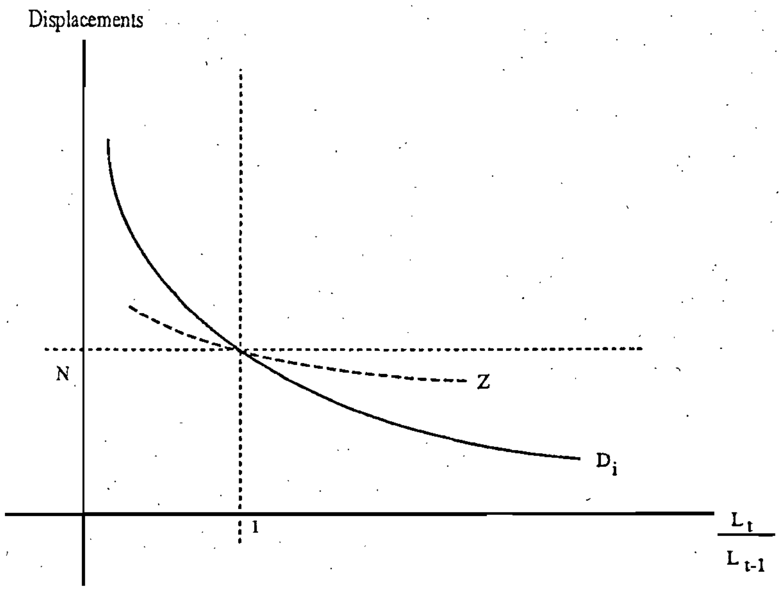
Replacing the change in employment with a first differenced version of equation (10) yields the following estimating equation:[5]

$$\ln D_i = \beta_1 + \beta_2 \left(\Delta \ln K_a \right) + \beta_3 \left(\Delta \ln L_a \right) + \beta_4 \left(\Delta \ln P_e \right) + \beta_5 \left(\Delta \ln P_a \right) \quad (13)$$
$$+ \beta_6 \left(\Delta \ln P_i{}^m \right) + \beta_7 \left(\Delta \ln P_i{}^x \right) + \beta_8 \left(\Delta \ln Q \right) + v_i,$$

[5] Estimates of equation (12) using observed changes in employment for single industries show N and n to be of the signs and magnitudes predicted by the theory.

Figure 1

Displacements As a Function of Changes in Labor Demand



where $\beta_1 = \ln N - n \cdot \delta_1$ includes both $\ln N$ from equation (12) and the constant vector resulting from the first differencing of the trend term in equation (10), and $\beta_i = n \cdot \delta_i$ $(i \geq 2)$, where the δ_i are, again, from equation (10). The independent variables are all measured as annual changes. The disturbance term, v_i, originates in equation (1) and enters (13) in the following form:

$$v_i = -\frac{n \cdot d}{1+d}\left[\frac{1}{\frac{a_1}{1+c} + \frac{a_2}{1+d} + \frac{1}{b_1+b_2+b_3-1}}\right](\epsilon_{i,t} - \epsilon_{i,t-1}), \tag{14}$$

which, based on the prior assumptions regarding ϵ_i, has a mean of zero and is serially uncorrelated.

Because of sample limitations, estimation of equation (13) necessarily involves pooling industries,[6,7] that is, imposing the restriction that $\beta_j = \beta_k$, for some or all industries

[6] A list of industries can be found in Table 1. The coverage of tradable industries is limited by the availability of import and export prices. Some aggregation of industries was also necessary in order to increase the reliability of the estimates of displaced workers.

[7] Ideally, equation (13) would be estimated separately for each of the 29 tradable industries for which data are available. Unfortunately, such estimation is not possible. Separate regressions would each include at most 9 observations, one for each year from 1981 through 1989. Consequently, the reported coefficient estimates are based on pooled time-series cross-section data.

j and k. Turning our attention first to β_1, the intercept, we can examine the components, $\ln N_i$ and $n \cdot \delta_1$, separately. It is surely the case that $\ln N_i$ differs across industries, and hence it is inappropriate to estimate a single constant term. One method of avoiding this problem is to include industry dummies in the regression. Given the small size of the sample, this is very costly in terms of lost degrees of freedom. An alternative is to remove the industry specific part of β_1, the equilibrium level of displacements, by moving it to the left–hand side. The dependent variable used in the estimation is therefore $\ln D_i - \ln N_i$, where $\ln N_i$ is approximated by the average annual number of displacements in industry i from 1979 to 1989.[8] The constant term in the regression is then $n \cdot \delta_1$. As discussed above, n is expected to be large in absolute value and will consequently dwarf δ_1. The coefficient on the intercept term is, therefore, not likely to be significantly different for each industry.[9] The estimation of a single intercept appears to be a reasonable restriction.

Unfortunately, there is no way of estimating separate slope coefficients. However, in the regression analysis of the next section, the industries are broken out into subsets designed to maximize the reliability of the coefficients on the trade variables. Separate coefficients are estimated for import–competing and export–competing industries.

When equation (13) is estimated using pooled data, it is likely that the efficiency of the estimates will be reduced by the presence of heteroskedasticity. Equation (14) can be used to generate some insight into the possible form of the heteroskedasticity. If we assume perfect capital and labor mobility, *i.e.*, if $c, d \to \infty$, then $\frac{d}{d+1} \to 1$, $\frac{a_2}{1+d} \to 0$ and $\frac{a_1}{1+c} \to 0$, and the error term is distributed normally with the following mean and variance:

$$E\left[v_i\right] = 0, \qquad E\left[{v_i}^2\right] = (b_1 + b_2 + b_3 - 1)^2 \cdot k^2 \cdot {\sigma_{v_i}}^2.$$

From this equation, we find that the heteroskedasticity is related to b_1, the elasticity of substitution between imports and the domestic output of industry i, b_2, the elasticity of

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8 This may not be appropriate for industries in gradual decline, or growth, throughout this period and may well reduce the significance of the coefficients on the trade price variables. The dummy variables approach suffers from the same flaw.

9 Statistical tests failed to reject the hypothesis that $(n \cdot \delta_1)_1 = (n \cdot \delta_1)_2 = \cdots = (n \cdot \delta_1)_N$ at the 99% level.

substitution between an aggregate bundle of goods and the output of industry i, and b_3, the elasticity of export supply. It is likely that these parameters differ across industries and hence that heteroskedasticity is a problem. If these parameters were observable, it would be possible to completely remove the inefficiency. Given that they are not observable, a statistical correction using proxies for each of these parameters is used.[10] This will permit an increase in the efficiency of the estimates

The proxies used in the correction for heteroskedasticity are the import penetration ratio (IPR) and a measure of industry exports (EPR), which are variables related to the trade elasticities. Industry production and employment are also included to account for differences in the variance based on industry size related to b_2, the elasticity of substitution between industry i's output and the aggregate bundle.

The industries analyzed are listed in Table 1. These 29 industries accounted for roughly 75% of all trade in 1981, and 70% of all displacements within traded sectors between 1979 and 1989.[11] Also reported in Table 1 are measures of import and export competition for 1981. Column 3 of Table 1 reports imports as a fraction of domestic sales (IPR) and Column 4 reports exports as a fraction of domestic production (EPR). Column 2 classifies each industry as either import–competing or export–competing. This classification is based on the ratio of IPR to EPR. If this ratio is greater than one, the industry is classified as import–competing, if less than one, it is classified as export–competing. Of the 29 industries, 15 are classified as export–competing and 14 as import–competing.

III. Data

The displacements data are from a relatively untapped source. In 1984, the Bureau of the Census began supplementing the January Current Population Survey (CPS) with a Survey of Displaced Workers (DWS). Subsequent volumes of the DWS have been conducted

[10] See Appendix A for an exposition of the method of correction employed.

[11] This represents 42% of the total displacements during the same time period.

Table 1
U.S. Industry Characteristics
(Based on 1981 Trade Data)

#	Industry	X or M[1]	IPR[2]	EPR[3]
1	Mining (Excl Petroleum)	X	4.80	11.10
2	Meat Products	M	3.99	3.93
3	Canned and Preserved Fruits and Vegetables	X	3.72	3.81
4	Dairy and Grain Products	X	3.95	4.27
5	Beverage and Misc. Food Products	X	5.84	6.74
6	Stone, Clay, Glass and Concrete Products	M	7.03	5.43
7	Furniture and Fixtures	M	5.17	2.74
8	Leather and Leather Products	M	39.72	5.55
9	Household Appliances	X	9.17	9.67
10	Radio, TV and Comm. Equipment	M	23.02	9.81
11	Motor Vehicles and Motor Vehicle Products	M	27.25	11.60
12	Misc. Plastic Products	X	3.47	6.09
13	Sawmills, Planing Mills & Millwork	M	12.89	6.42
14	Lumber & Wood Products (Excl Furniture and 13)	X	2.90	8.81
15	Apparel	M	16.03	3.21
16	Paper and Allied Products	M	6.90	5.74
17	Chemicals and Allied Products	X	5.37	13.31
18	Petroleum and Rubber Products	M	8.45	2.23
19	Primary Metal Industries	M	20.66	8.37
20	Fabricated Metal Products	X	4.16	6.99
21	Engines, Turbines and Farm Machinery and Equipment	X	12.22	20.32
22	Construction and Material Handling Machines	X	8.58	36.87
23	Office Machines	X	12.65	26.85
24	Textile Mill Products	M	8.45	6.26
25	Electrical Machinery nec	X	15.21	17.14
26	Transportation Equipment	M	12.49	8.73
27	Professional and Photographic Equipment	X	17.12	19.01
28	Aircraft and Parts	X	19.50	60.60
29	Metalworking Machinery	X	12.75	13.36

Source: Calculations by the author from the NBER Trade Database.
[1] Classified as M if IPR is greater than EPR, and X otherwise.
[2] Imports as a percent of domestic sales.
[3] Exports as a percent of domestic production.

in every other year since 1984. Given the sampling procedure, these surveys include all information that could have been obtained from conducting additional surveys in 1985, 1987, 1989 and 1991.[12] This survey provides detailed microeconomic data on individuals who were displaced during the five year period prior to the survey. These data include information on both an individuals' pre–displacement situation, *e.g.*, industry and wages, as well as information on their current status, *e.g.*, employed or unemployed along with wages and industry if reemployed. By combining the four DWS tapes, a continuous time series of displacements by three digit census industry can be formed for 1979 through 1989.

The sample used in the estimation consists of full–time workers, aged 18 to 64, that were employed in the industry from which they were displaced for a minimum of two years. The sample excludes those reporting the reason for displacement as other than: plant or company closed down or moved, slack work, or position or shift abolished. Also excluded are observations of individuals displaced within a year of their particular survey if the individual is still unemployed at the survey date. This reduces the chances of including individuals that perceived themselves as displaced at the time of the survey, but were subsequently recalled by their previous employers. By making these exclusions, the estimation results represent structural change within the industries; *i.e.*, transitional displacement, part–time workers and temporarily displaced workers are not included.

The producer price index is used for the aggregate price level, and aggregate industrial production is used as a proxy for real national income. These data, as well as the price of energy, are available from the *Survey of Current Business.* The disaggregated import and export price variables are from a database maintained by the Department of Labor. The trade prices are available by 4–digit Standard Industrial Classification (SIC) codes and are concorded to the Census classification using the 1985 trade values as weights. The trade price indices are based on actual transaction prices.[13]

The import price index is calculated on a c.i.f. (cost, insurance, and freight) basis

[12] Half of the individuals surveyed in the 1985 CPS, for instance, were surveyed in 1984, while the rest were surveyed again in 1986.

[13] See the BLS Handbook of Methods for further information regarding import and export prices.

and is adjusted to reflect import duty information where appropriate. The export price index is reported on a f.a.s. (free alongside ship) basis at the U.S. port of exportation. The appropriate measure for addressing issues of competitiveness would be on a c.i.f. basis, as this is a more accurate reflection of what the domestic producer receives than is f.a.s. The export prices are not, however, available on a f.a.s. basis. The omitted insurance and transportation costs will undoubtedly reduce the importance of export prices in determining changes in displacements.

The aggregate capital stock is available from the U.S. Department of Commerce publication *Fixed Reproducible Tangible Wealth in the States, 1925–85* for 1980 through 1985. Thereafter, it is estimated as

$$K_{t+1} = I_t + (1 - \delta_t) K_t, \tag{15}$$

where I_t is gross investment in plant and equipment and δ_t is the rate of depreciation in year t. The value of δ_t for 1975 through 1985 is calculated using values of depreciation and discards published along with the data on net capital stocks. The calculated rate of depreciation for 1975 through 1985 appears to have been slowly increasing over time. The value of δ_t for 1986 through 1989 is therefore predicted from the regression of the calculated δs, for 1975 through 1985, on a constant and a trend term. Figures for gross investment as well as data on the aggregate labor force are from the *Survey of Current Business.*

IV. Results

The regressions were performed using both ordinary least squares and feasible generalized least squares (FGLS) correcting for heteroskedasticity. Statistical tests reveal that IPR, EPR, and industry production and employment, are in fact significantly related to the heteroskedasticity exhibited by the OLS residuals. Table 2, therefore, presents only the FGLS results.

Two different specifications of equation (13) were estimated, equation (13) as it appears in the text, and equation (13) omitting the export price variable. This alterna-

Table 2
The Influence of International Prices on Displacements
(Standard Errors in Parentheses)

Sample	Specification 1 P^x	Specification 1 P^m	Specification 1 R^2	Specification 2 P^m	Specification 2 R^2	N
(i) All Industries	−0.158 (0.760)	−1.621** (0.556)	.267	−1.692** (0.532)	.256	236
(ii) Import–competing	−0.114 (0.588)	−3.662** (0.955)	.375	−3.575** (0.809)	.366	126
(iii) Export–competing	−0.359 (0.710)	−0.695 (0.556)	.318	−0.676 (0.532)	.314	110

Specification 2 does not include the export price as a regressor variable.
Tables containing a complete set of coefficients can be found in Appendix B.
*Significant at the 95% level.
**Significant at the 99% level.

tive specification was estimated in an effort to provide an indication of how important the exclusion of the export price might have been in previous studies. These alternative specifications were estimated using three different samples. The first set of coefficients is based on the entire sample. The second and third sets of coefficients are based on samples including only import-competing and export-competing industries, respectively. These last two subsets were chosen because the coefficients on the trade price variables are likely to differ the most between these two groups. Chow tests for structural change easily reject the hypothesis that the coefficients for the import-competing industries are the same as those for the export competing industries.

The interpretation of the coefficients is as follows. A value of −1.621 for the import price coefficient means that a one percent increase in the import price between one year and the next will result in roughly a 1.62 percent decline in displacements for a given industry in a given year. Thus, the results presented indicate that increases in import prices reduce displacements in both export and import competing industries. The effect is, as anticipated, strongest for import competing industries, where a one percent increase in the price of imports results in over a three and one half percent decline in displacements.

The influence of changes in the import price does appear to be important for explaining changes in displacements, while changes in the export price do not appear to have a substantial impact.[14] This quite possibly reflects the nature of the market structure of industries for which exports make up a large share. Notably, aircraft and parts (industry 28) much more closely resembles a monopolistic industry than a perfectly competitive industry. Changes in demand in monopolistic markets result in smaller changes in output and hence smaller changes in displacements. It is also quite possible that exporters are slower to respond to changes in prices than are consumers. Given that domestic producers may be primarily concerned with production for the domestic market, responses to changes in export prices may well come slowly, if at all.[15]

A comparison of Columns 2 and 4 of Table 2 reveals that omitting the export price variable does not impose a large bias on the import price variable. This is a somewhat surprising result. It is reasonable to believe that the export and import prices in a given industry are highly collinear. In fact, in a perfectly competitive world with homogeneous goods, one would expect them to move together. If these variables were highly collinear, the exclusion of the export price would have a significant impact on the coefficient of the import price variable. The evidence presented, therefore, suggests that the previous studies, to the extent that they had as their intent the measurement of the effect of import competition alone, did not present results that were significantly biased by the exclusion of the export price.

[14] The omission of transport and insurance costs from the export price, because of the f.a.s. reporting basis, will bias the coefficient on the export price variable towards zero.

[15] There is a growing literature on exchange rate pass through. This is the situation in which exporters do not pass changes in exchange rates through to the foreign consumers. The existence of this phenomenon means that exporters will not alter their production in response to what appear to be price changes. The coefficient on the export price variable will, as a result, be somewhat lower than might otherwise be expected.

V. Counterfactual

Using the results from the initial regressions, we now quantify the effect of changing trade patterns on the level of displacements in the 1980s. This is accomplished by measuring changes in international competition and predicting the level of displacements that would have occurred in the absence of changes in international competition.

To generate counterfactuals, an array of import and export prices representing neutral international competition is needed. Neutral international competition means the absence of changes in the competitive advantage of domestic firms relative to their foreign counterparts. As in Grossman, a constant price of imports and exports relative to the aggregate price level is assumed to represent neutral international competition, *i.e.*,

$$\frac{P^{m}{}_{i,t}}{P^{a}{}_{t}} = \frac{P^{m}{}_{i,1980}}{P^{a}{}_{1980}}, \qquad t = [1981, \ldots, 1989], \quad (16)$$

and similarly for export prices.[16] For the current framework, this implies replacing $d\ln P_i^m$ and $d\ln P_i^x$ with values representing neutral import competition. With a little manipulation, it can be shown that the restriction presented in equation (16) implies replacing each of the trade variables with $d\ln P_a$. Predictions using the changes in the aggregate price level in place of changes in trade prices will then yield estimates of the level of displacements that would have been observed in the absence of changes in international competition.

The number of displacements generated by changes in the competitive environment is calculated using the following formula:

$$\left[\frac{D_p - D_n}{D_p}\right] \cdot D_a = D_{ic}, \quad (17)$$

where D_p is the predicted level of displacements allowing changes in international competition, *i.e.*, the fitted value, D_n is the predicted level of displacements under the assumption of neutral import competition, and D_a is the actual number of displaced workers in the

[16] A perhaps more desirable definition would be a constant price of imports and exports relative to the domestic price in the industry. The endogeneity of industry prices in this model prevents the use of this measure.

industry.[17] D_{ic} is then the number of displacements resulting from changes in international competition.

In order to emphasize the different effects of import and export competition, three sets of counterfactuals are generated. The first set presents the displacements resulting from changes in import competition alone, the second is generated by changes in export competition alone, while the third set includes changes in both import and export competition. The coefficients used in the predictions are from regression (ii) for import–competing industries and from regression (iii) for export-competing industries as reported in Table 2. Some aggregated results are provided in Tables 3 and 4. The changes in the trade prices relative to the aggregate price level are presented in Table 5, along with the number of displacements caused by the changes in competitiveness.

Table 3 shows that the effect of international competition accumulated throughout the 1980s was not very large. To the extent that it had any effect, it served to reduce the aggregate number of displacements. Overall, there were approximately three thousand fewer displacements than there would have been in the absence of changes in competitiveness. In 18 of the 29 industries examined, the number of displacements was lower than it would have been in the absence of changes in international competition. Two industries experienced a significant reduction; motor vehicles (12) and other transportation equipment (27) were each given a substantial boost by changes in the competitive environment. Both industries were the source of approximately twenty thousand fewer displaced workers than would have otherwise been the case. This is largely due to a significant increase in the import price above increases in the aggregate price level for both of these industries between 1984 and 1987.

Only eleven industries experienced a larger number of displacements than they would have absent changes in international competition. Primary metals industries (19) heads the list with 29 thousand displacements resulting from increased import competition;

[17] $D_a - D_n$ is perhaps a more straightforward method of calculating the change in displacements due to trade, but this would attribute to import competition the residuals from the estimating equation.

Table 3
Breakdown of Displacements by Industry for 1981 through 1989

#	Industry	Displacements Actual	Change due to:[1] M	X	M+X
1	Mining (Excl Petroleum)	139,987	6,879	1,016	7,895
2	Meat Products	89,867	11,425	402	11,827
3	Canned and Preserved Fruits and Vegetables	64,826	952	77	1,028
4	Dairy and Grain Products	63,438	–808	691	–116
5	Beverage and Misc Food Products	48,755	–718	–118	–837
6	Stone, Clay, Glass and Concrete Products	151,622	2,075	-1,060	1,015
7	Furniture and Fixtures	158,012	–1,093	–78	–1,170
8	Leather and Leather Products	101,422	–703	–581	–1,284
9	Household Appliances	52,231	109	–105	4
10	Radio, TV and Comm Equipment	120,110	5,037	212	5,249
11	Motor Vehicles and Motor Vehicle Products	352,222	–11,210	701	–10,509
12	Misc. Plastic Products	53,733	–1,156	281	–875
13	Sawmills, Planing Mills & Millwork	109,550	9,013	34	9,047
14	Lumber & Wood Products (Excl Furniture and 13)	95,932	–177	–209	–386
15	Apparel	363,905	–6,848	-2,364	–9,212
16	Paper and Allied Products	89,295	2,554	–762	1,792
17	Chemicals and Allied Products	150,113	–11	105	94
18	Petroleum and Rubber Products	45,440	–6,502	–549	–7,051
19	Primary Metal Industries	282,613	30,877	-1,189	29,687
20	Fabricated Metal Products	261,595	–4,102	-1,257	–5,359
21	Engines, Turbines and Farm Machinery and Equipment	426,770	–538	-3,042	–3,580
22	Construction and Material Handling Machines	165,095	130	–647	–517
23	Office Machines	123,727	976	869	1,845
24	Textile Mill Products	149,899	–8,195	–486	–8,681
25	Electrical Machinery nec	324,679	–1,937	–385	–2,322
26	Transportation Equipment	187,329	–17,682	3,777	–13,904
27	Professional and Photographic Equipment	149,788	–605	–664	–1,269
28	Aircraft and Parts	127,834	–3,155	–1,167	–4,322
29	Metalworking Machinery	79,427	–1,003	–76	–1,079
	Total	4,529,214	–2,991	–6,578	3,587

[1] M and X refer to the import and export prices, respectively.

this is an increase in displacements of more than 10% in the primary metals industries during the 1980s. Three other industries, mining (1), meat products (2), and sawmills, planing mils and millwork (13), each suffered in excess of 7,500 displacements as a result of increased trade competition.

From Table 4, it becomes apparent that some of the results in Table 3 are somewhat misleading in terms of the effects of import competition. The effects of international competition differ greatly in the two halves of the 1980s. The first half, a period characterized by a greatly over-valued dollar, is also characterized by a significant number of displacements resulting from trade. Some 115 thousand workers were displaced between 1980 and 1985 that would not have been were it not for changes in international pressures. The second half of the 1980s is remarkably different. Throughout this period, exchange rates came back in line and 118 thousand workers benefited directly. Most notably, displacements were reduced by more than 60 thousand in 1986. A significant depreciation of the dollar at this time is undoubtedly driving this dramatic shift in displacements between 1985 and 1986.[18]

Several of the individual industries exhibit the same pattern as the aggregate numbers. As reported in Table 5, stone, clay, glass, and concrete products (6), for instance, had an increase of seven thousand displacements before 1986. A large increase in the price of imports from 1986 through 1989 subsequently reduced this number significantly, so that in all, only two thousand workers were displaced by international trade in the 1980s.[19] Leather and Leather Products (8) suffered five thousand displacements before 1986, and again largely recovered thereafter. Apparel (15) suffered nine thousand displacements before recovering in the last half of the 1980s, and actually wound up with nine thousand fewer displaced workers over the course of the decade.[20]

Among the surprising results is the ten thousand fewer workers displaced from the

18 The real multilateral trade-weighted value of the U.S. dollar fell by 30% between 1985 and 1986.

19 The question of the equivalence between displacements caused by trade and displacements prevented by trade is addressed in Haveman (1993).

20 See Appendix B for a detailed listing of industry displacements by year.

Table 4
Breakdown of Displacements by Year for 1981 through 1989

	Displacements			
		Change due to:		
Year	Actual	Import Price	Export Price	M+X
1981	378,933	64,102	–1,531	62,572
1982	574,594	31,147	–377	30,770
1983	689,962	10,986	28	11,014
1984	540,342	6,058	–1,071	4,987
1985	712,690	7,086	–1,581	5,505
Sub-Total	2,896,521	119,379	–4,532	114,848
1986	447,284	–59,727	–846	–60,573
1987	430,524	–52,944	988	–51,955
1988	335,283	–15,399	–1,050	–16,449
1989	419,601	12,278	–1,138	11140
Sub-Total	1,632,692	–115,792	–2,046	–117,837
Total	4,529,213	3,587	–6,578	–2,991

motor vehicle and motor vehicle products industry (11). At the same time that much was heard from the United Auto Workers especially regarding the negative impact of foreign competition, foreign competition in fact appears to have been in decline. This result is largely to be taken as evidence that the voluntary export restraints maintained by the Japanese throughout most of the 1980s were quite effective. Another reason for this apparent contradiction could be the growing practice of outsourcing the production of "American" automobiles, most notably to northern Mexico.

VI. Conclusions

This study, through the analysis of displacements rather than employment levels, and formal modelling of the export sector, sheds new light on the effects of trade competition on domestic labor. The picture painted here suggests that although displacements, and hence the adjustment costs, resulting from a decline in competitiveness were signifi-

Table 5

Change in Trade Prices
Relative to Aggregate Price Index
(Percent Change Relative to Changes in the Aggregate Price Level)

#	Industry	Trade Displacements	Change in Price: Import	Change in Price: Export
1	Mining (Excl Petroleum)	7,895	–42.80	–20.90
2	Meat Products	11,827	–39.73	22.32
3	Canned and Preserved Fruits and Vegetables	1,028	–13.92	–2.74
4	Dairy and Grain Products	–116	5.45	–25.21
5	Beverage and Misc. Food Prods.	–837	9.87	–1.24
6	Stone, Clay, Glass and Concrete Products	1,015	14.03	–22.22
7	Furniture and Fixtures	–1,170	–2.70	–1.18
8	Leather and Leather Products	–1,284	–1.74	–22.22
9	Household Appliances	4	11.06	12.24
10	Radio, TV and Comm. Equipment	5,249	–8.02	3.50
11	Motor Vehicles and Motor Vehicle Products	–10,509	17.24	12.19
12	Misc. Plastic Products	–875	28.87	–10.21
13	Sawmills, Planing Mills & Millwork	9,047	–9.33	18.29
14	Lumber & Wood Products (Excl Furniture and 13)	–386	9.68	30.98
15	Apparel	–9,212	7.60	–22.22
16	Paper and Allied Products	1,792	7.87	4.58
17	Chemicals and Allied Products	94	8.68	7.44
18	Petroleum and Rubber Products	–7,051	14.30	–21.65
19	Primary Metal Industries	29,687	–0.45	–2.02
20	Fabricated Metal Products	–5,359	23.91	12.99
21	Engines, Turbines and Farm Machinery and Equipment	–3,580	7.50	17.56
22	Construction and Material Handling Machines	–517	9.02	4.08
23	Office Machines	1,845	–15.17	–32.02
24	Textile Mill Products	–8,681	24.47	–11.47
25	Electrical Machinery nec	–2,322	7.82	0.62
26	Transportation Equipment	–13,904	30.16	43.13
27	Professional and Photographic Equipment	–1,269	–3.81	10.85
28	Aircraft and Parts	–4,322	30.16	35.92
29	Metalworking Machinery	–1,079	10.71	–1.96

cant in the early 1980s, they were on the whole very small over the entire decade of the 1980s. The inclusion of the export price produces results that suggest a bias in the results presented by previous authors; the size of this bias is, however, quite small in most cases.

The results obtained seem to correlate highly with changes in exchange rates. The overvalued dollar of the early 1980s is associated with relatively large levels of displacements resulting from changes in the trading environment. The rapid depreciation between 1985 and 1986, continuing throughout the latter part of the 1980s, is reflected in an abatement of international competition and a reduction in observed displacements. This suggests that structural changes in the global competitiveness of domestically produced goods are perhaps not as severe as popular opinion and previous analyses might suggest.

Also worthy of note is the small role played by international trade in determining the level of displacements in any given year. In only one of the nine years does trade explain more than 10% of the observed displacements. In all of the other years trade is responsible for less than 5% of all displacements, and in fact serves to reduce the volume of displacements in three of the nine years. The results of the analysis therefore suggest that although international trade has certainly served to reduce employment in some industries, and on an individual industry basis has resulted in a significant number of displacements, trade does not appear, in the aggregate, to be as injurious to overall employment as those calling for protectionism might suggest.

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APPENDIX A

STATISTICAL CORRECTION FOR HETEROSKEDASTICITY

We are estimating a linear model:[21]

$$y_i = x'_i\beta + e_i, \qquad i = 1, \ldots, N, (A.1)$$

where e_i is distributed normally and has the following mean and variance:

$$E(e_i) = 0, E({e_i}^2) = {\sigma_i}^2 = (z_i'\alpha)^2$$

This is a model suffering from heteroskedasticity where the z_i are observable. The correction for heteroskedasticity involves estimating α. The algorithm laid out below provides an efficient means of estimating α.

The procedure begins by producing the residuals from the ordinary least squares estimation of equation (A.1), $\hat{e}$. The second step generates a first estimate of α. This estimate is arrived at by performing the following regression:

$$|\hat{e}_i| = c{z_i}'\alpha + v_i, \qquad (A.2)$$

where $v_i = |\hat{e}_i| - c\sigma_i$. Applying ordinary least squares we obtain

$$\widehat{c\alpha} = (Z'Z)^{-1}Z'|\hat{\mathrm{e}}|. \qquad (A.3)$$

Given the normality of e_i, it can be shown that $c = \left(\frac{1}{\pi}\right)^{\frac{1}{2}}$. It can be shown that the v_i are also heteroskedastic. In order to obtain efficient estimates of $\hat{\alpha}$, it is necessary to correct (A.2) for heteroskedasticity.

The following is an algorithm for obtaining efficient estimates of the βs in equation (A.1):

[21] See Fomby *et al.*, pg. 180.

1. Obtain the ordinary least squares estimate $\widehat{c\alpha}$. For known c, $\hat{\alpha} = \widehat{c\alpha}/c$.
2. Construct $\hat{\Sigma}_2$, a consistent estimate of the error covariance Σ_2 of the estimating equation (2). $\hat{\Sigma}_2$ is a diagonal matrix with the i^{th} diagonal element $(1-c^2)(z_i'\hat{\alpha})^2$.
3. Construct the feasible generalized least squares estimator of $c\alpha$

$$\widehat{\widehat{c\alpha}} = (Z'\hat{\Sigma}_2^{-1}Z)^{-1}Z'\hat{\Sigma}_2^{-1}|\hat{e}|.$$

The corresponding feasible generalized least squares estimate of β is then arrived at by using $\hat{\Sigma}_3$, a diagonal matrix with i^{th} element $(z'\widehat{\widehat{c\alpha}}_i)^2$, and calculating the estimates as:

$$\hat{\beta}_{fgls} = (X'\hat{\Sigma}_3^{-1}X)^{-1}X'\hat{\Sigma}_3^{-1}Y.$$

APPENDIX B

COMPLETE REGRESSION RESULTS

Table B.1

Description of Variables

Variable*	Description
DDISPL	The deviation from the historical average number of displacements in the industry.
EXPPRI	The export price index.
IMPPRI	The import price index.
PRODN	An index of industrial production in the U.S. economy.
PPRICE	The producer price index.
EPRICE	The energy price index.
LFORCE	An index of the aggregate U.S. labor force.
KSTOCK	An index of the aggregate capital stock.
IPR	Imports as a percent of domestic market sales.
EPR	Exports as a percent of domestic industry production.
INDPR	An index of industry level production.
INDEMP	Industry employment as a percent of 1980 aggregate employment.

*The regressor variables, DDISPL through KSTOCK are measured as log differences.

Table B.2

Simple Statistics

	All Industries		Import competing		Export competing	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Regression Variables:						
DDISPL	–0.064	(0.600)	–0.044	(0.587)	–0.079	(0.611)
EXPPRI	0.024	(0.065)	0.020	(0.078)	0.026	(0.054)
IMPPRI	0.028	(0.069)	0.032	(0.056)	0.025	(0.077)
PRODN	0.032	(0.045)	0.030	(0.047)	0.033	(0.044)
PPRICE	0.022	(0.029)	0.022	(0.030)	0.021	(0.029)
EPRICE	–0.025	(0.113)	–0.022	(0.113)	–0.026	(0.113)
LFORCE	0.016	(0.003)	0.016	(0.003)	0.016	(0.003)
KSTOCK	0.029	(0.007)	0.029	(0.007)	0.030	(0.007)
Variables used in correction for heteroskedasticity:						
IPR	0.100		0.131		0.077	
EPR	0.120		0.064		0.162	
INDPR	60,813		65,931		56,985	
INDEMP	0.774		0.852		0.716	
N	236		126		110	

Table B.3

Complete Regression Results – All Industries

(Standard Errors in Parentheses)

	All Industries (1)	All Industries (2)	Import Competing (1)	Import Competing (2)	Export Competing (1)	Export Competing (2)
EXPPRI	–0.158	–	–0.114	–	–0.359	–
	(0.588)		(0.760)		(0.710)	
IMPPRI	–1.621	–1.692	–3.662	–3.575	–0.695	–0.676
	(0.553)	(0.532)	(0.955)	(0.809)	(0.556)	(0.532)
PRODN	–1.330	–1.556	–0.072	–1.005	–3.022	–3.124
	(1.182)	(1.171)	(1.558)	(1.546)	(1.565)	(1.540)
PPRICE	–10.033	–9.664	–3.349	–2.272	–15.088	–14.613
	(3.054)	(3.025)	(4.173)	(4.197)	(3.973)	(3.808)
EPRICE	3.010	2.993	1.715	1.761	3.886	3.840
	(0.706)	(0.710)	(0.984)	(0.994)	(0.883)	(0.868)
KSTOCK	–26.703	–30.432	–19.052	–28.547	–43.032	–45.201
	(15.767)	(15.636)	(20.853)	(21.005)	(20.262)	(19.588)
LFORCE	19.124	24.929	6.230	25.166	75.512	77.337
	(40.529)	(40.564)	(54.374)	(54.971)	(51.006)	(50.357)
CONSTANT	0.769	0.822	0.633	0.684	0.503	0.547
	(0.268)	(0.265)	(0.349)	(0.348)	(0.358)	(0.346)
R^2	.267	.256	.375	.366	.318	.314
N	236		126		110	

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